Hydroclimatic Reconstructions for Decision Support in the Colorado River Basin

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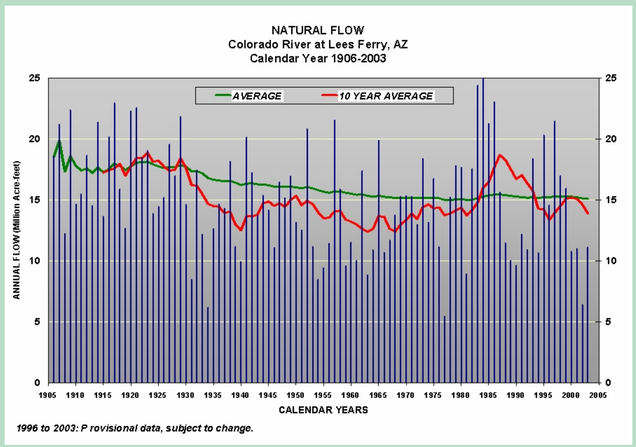
BACKGROUND

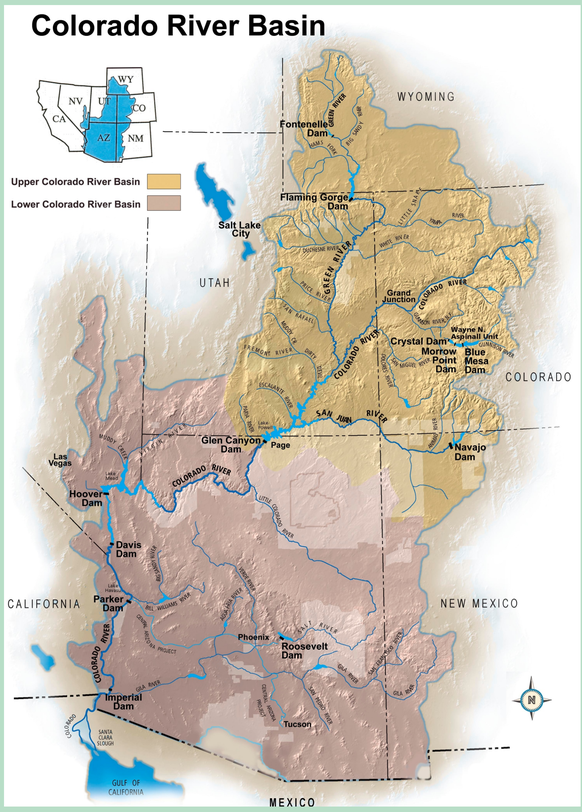
Recent drought conditions (2000-2004) across the western U.S. created a window of opportunity for collaborations between paleoscientists and water resource managers. Drought severity, particularly in 2002, was unprecedented in many gage records, leading to the question, do gage records contain an adequate frame of reference for drought planning? In the Colorado Front Range, partnerships between scientists and water management agencies have resulted in tree-ring based streamflow reconstructions that are now being used in planning and management (see box to the far right). Collaborations in Arizona with the Salt River Project have also been productive.



COLORADO RIVER NATURAL FLOWS
MAJOR DROUGHTS of the
20th and 21st CENTURIES

Years	Duration	Average flow
1931-1935	5 yrs	11.4 MAF
1953-1956	4 yrs	10.2 MAF
1959-1964	6 yrs	11.4 MAF
1988-1992	5 yrs	10.9 MAF
2000-2004	**5 yrs**	**9.9 MAF**

Estimated natural water year flows at Lees Ferry from U.S. Bureau of Reclamation (left). Lees Ferry is the gaging stations that measures flows from the upper Colorado River at Lake Powell. Major multi-year droughts (above) are based on Lees Ferry natural flows from 1906-2004. Map of Colorado River basin, courtesy of the U.S. Bureau of Reclamation (right).

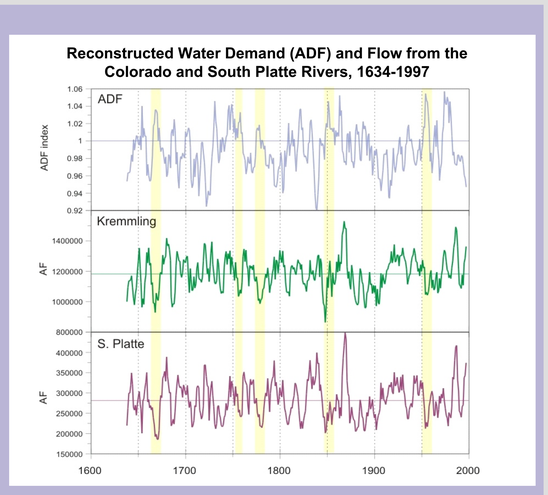


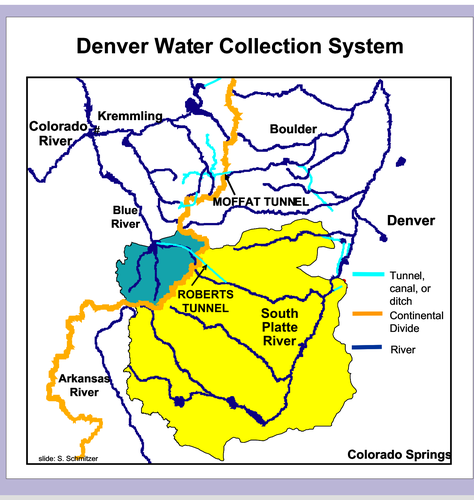
Denver Water
Colorado's largest water provider

Denver Water is Colorado's oldest water utility, serving over one million people in the Denver metropolitan area, with water supplies from both the Upper Colorado and South Platte River basins. Denver Water wanted to determine if the 1950s drought was an adequate worst-case-scenario for drought planning and how well their system could handle an even more severe drought. Tree-ring based reconstructions of South Platte and Colorado River flows provided evidence of a broader range of droughts (right), but the challenge was to find a way to take the annual reconstructed values for a small number of gages and convert them into the input needed for the Denver Water system model.

Denver Water uses a water system model called the Platte and Colorado Simulation Model (PACSM). PACSM is an intergrated system that simulates streamflows, reservoir operations, and water supplies in the South Platte and Colorado River basins (map, right). The model input is daily data from 450 locations for 1947-1991.

In order to use the tree-ring reconstructions in the model, an "analogue year" approach is being developed to match each year in the reconstructed flows with one of the 45 model years with known hydrology (e.g., 1655 is matched with 1963. Years with more extreme wet/dry values are scaled accordingly. Then the data files will be assembled as new sequences of model years, and PACSM will be used to simulate the entire tree-ring period, 1650-2002.





BROADENING the SCOPE and APPLICATIONS OF PALEOCLIMATIC INFORMATION in WATER RESOURCES MANAGEMENT

In May 2005, a workshop was held to bring together paleoclimatologists, hydrologists, climatologists, and resource managers concerned with Colorado River basin water supplies, to share lessons learned and to chart a course for future collaborations.

Key findings included:

- Water resource managers value tree-ring reconstructions of streamflow for assessing gage records in a broader context of hydroclimatic variability and thus are potentially useful for decision support.
- Two-way knowledge exchange is critical for scientists' understanding of decision-making concerns, and water mangement's understanding of the science behind the data. Mutual understanding can reduce barriers to paleodata use in decision-making. Collaborative partnerships are key to developing and providing useful and usable paleoclimatic information for decision support.
- Water resource managers are accustomed to working with uncertainties, but more transparent characterization of the uncertainties in the tree-ring based reconstructions are needed.
- Water resource managers are concerned about the hindcast skill of the reconstructions, and perplexed by the type of skill measures used by the paleoclimatology community.

Workshop Funding: **NOAA OGP Climate Change Data and Detection, Human Dimensions, and Regional Integrated Science Assessments**
Organizing Committee: **Gregg Garfin, Connie Woodhouse, Robert Webb, David Meko, Brad Udall, Kathy Jacobs**
Web Site: **http://www.ispe.arizona.edu/climas/conferences/CRBpaleo/index.html**

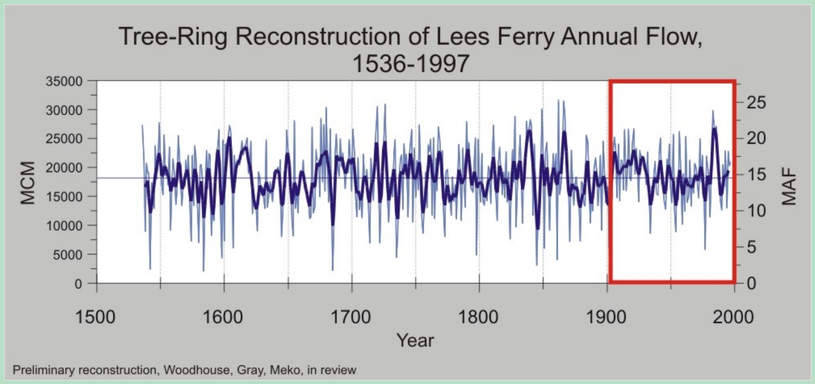
FUTURE DIRECTIONS

Needs identified by water resource managers have provided guidance for future activities and collaborations.

Recommendations include:

- Technical training for operational use of paleodata to analyze system sensitivity to prolonged or severe drought.
- General information workshops for higher-level water resource decision-makers and their publics.
- Online information and resources to make paleodata accessible and usable for water resource applications.

We are in the process of following up on these recommendations in coordination with an advisory board of water management personnel. We will be investigating ways to measure the effectiveness of these collaborations and activities, with a goal of further broaden the scope of this work to other river basins.



The reconstruction of Lees Ferry flow indicates that the early decades of the 20th century, the period upon which the Colorado River Compact was based, was one of the wettest periods in the past five centuries, while the worst drought in the 20th century, the 1950s drought, was not unusual. These findings have important implications for water resource management.